REMARKS

In response to an Office Action mailed on March 16, 2004, Applicant respectfully requests that the above-listed Amendments be entered and the Application be reconsidered. With entry of the above-listed Amendments, Claims 1, 3-8, 13-16 and 20-21 are amended; Claim 2 is canceled; Claims 9-12, 18 and 19 are withdrawn and Claims 22 and 23 are new. Thus, 17 claims are presented for examination. Of these, Claims 1 and 22 are independent, and the remaining claims are dependent.

The Applicant confirms the election of Group I. Claims 9-12, 18 and 19 are withdrawn.

The Examiner correctly noted that the declaration listed an incorrect filing date for the priority document. This fact was noted in the Transmittal Form for Filing Patent Application that accompanied this Application when it was filed.

The Examiner objected to several drawings for various reasons. Proposed replacement drawings are filed here with, as discussed above. The Examiner objected to Figs. 10, 12 and 13, however during a telephonic interview with the Examiner on August 3, 2004, these drawings were discussed and the Examiner withdrew these objections.

The Examiner objected to the disclosure for several informalities. The specification and the drawings have been amended to address these informalities.

The Examiner rejected Claims 1-8, 13-17, 20 and 21 under 35 U.S.C. 103(a) as being obvious over US Pat. No. 4,194,028 to Sirtl, *et al.* ("Sirtl") in view of US Pat. No. 5,911,824 to Hammond, *et al.* ("Hammond"), published Japanese patent application number JP 2000-247779 A to Yamamoto ("Yamamoto"), US Pat. No.

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4,741,925 to Chaudhuri, *et al.* ("Chaudhuri") and the Applicant's admitted prior art ("AAPA").

Sirtl discloses a reactor for coating a surface of a crucible by vapor deposition. Reactive gas is fed into Sirtl's reactor and directed into the interior of a crucible 5 by a gas inlet 8. (Figure and Col. 4, ll. 29-41.) As can be seen in the figure, all of the introduced reactive gas is directed into the interior of the crucible 5.

The present application is directed at apparatus and methods for densifying one or more hollow porous substrates by chemical vapor infiltration. Embodiments of the invention direct <u>only a portion</u>, i.e. less than all, of the reactive gas to an inside volume defined by a concave inside face of each substrate. These embodiments direct another portion of the reactive gas to an outside face of the substrate. The gas directed to the outside face can include some or all of the gas that is directed to the inside face. However, at least some fresh gas is directed to the inside face, and some fresh gas is directed to the outside face. Furthermore, if plural substrates are densified together, each of the substrates receive some fresh reactive gas.

The Examiner interpreted "part of the reactive gas flow" and "a fraction of the total admitted gas flow," as recited in Claim 1, to include substantially all, i.e. ~100% of the gas flow. Claim 1 has been amended to recite "dividing at least a portion of the reactive gas flow entering the enclosure into first and second non-zero fractions, wherein the first fraction of the reactive gas flow is fed to the inside face of the at least one substrate and the second fraction of the reactive gas flow is fed to the second face of the at least one substrate." New claim 22 recites

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"directing a first non-zero portion, but not all, of the reactive gas flowing through the enclosure into the inside volume of the substrate" and "feeding a second non-zero portion of the reactive gas flow through the enclosure to the second face of the substrate." Thus, none of the independent claims can be fairly interpreted to recite that substantially all of the reactive gas flows to the inside face of the substrate, as disclosed in Sirtl.

In Sirtl, a process is disclosed to form a protective coating on the surface of a shaped carbon crucible which is designed to be in contact with molten silicon. The protective coating is formed by chemical vapor deposition. As shown in the Figure, the carbon crucible is placed in a reactor and reactive gas is admitted through a tube 8 which penetrates into the reactor and opens into the inside of the crucible 5. The entire admitted reactive gas flow sweeps the inside face of the crucible and effluent gas appears to be extracted through a gas outlet 9 situated below the location of the crucible in the reactor.

The object is to form a suitable coating on the inside face of the crucible (Col. 4, l. 50-54), since the inside face is the only one designed to be contacted by molten silicon contained in the crucible during use of the latter (Col. 1, l. 54-58).

On its path between the extremity of tube 8 and gas outlet 9, gas flows along the inside face of the substrate and thereafter between the outside lateral face of the crucible and the lateral wall of the reactor. Since the reactive gas flow admitted through tube 8 has generated a coating on the inside face of the crucible, the gas flowing along the outside lateral face of the crucible is no more fresh: it has matured and suffers from depletion.

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As is explained in the specification of the present application, such changes in characteristics of the gas may lead to undesired deposits, namely deposits having a nature or a microstructure different from the ones sought (page 2, l. 35 to page 3, l. 16). In addition, in the reactor of Sirtl, the lateral wall of the reactor is cooled to prevent deposition thereon (Col. 4, l. 54-57). Since the outside lateral face of the crucible is directly and closely facing the cooled reactor wall, the temperature of the outside lateral face is inevitably lower than that of the inside face, due to heat radiation. This is a further reason for any possible deposit formed on the outside lateral face of the crucible to be different of the one formed on the inside wall and have unpredictable and undesired characteristics.

There is no disclosure in Sirtl to divide the admitted reactive gas flow to allow a fraction of "fresh" reactive gas to feed each one of the inside face and the outside face of the crucible. On the contrary, Sirtl clearly teaches ensuring that the total admitted reactive gas flow is directed to the inside face of the crucible where the desired coating is to be formed.

Hammond also disclose providing the internal face of a carbon crucible with a protective coating by a chemical vapor deposition process (Col. 2, l. 65 to Col. 3, l. 15).

Although Hammond mentions that impregnation and/or coating of the carbon crucible can be performed in/on the outside surface as well as in/on the inside surface (Col. 6, l. 41-45), Hammond does not describe a process that enables such a result to be satisfactorily achieved.

Yamamoto disclose a method for providing a carbon/carbon (C/C) bowl with a protection against reactivity with a quartz

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crucible. The C/C bowl is densified with SiC, whereby a bowl of C/C-SiC type is obtained (two-phase matrix: C and SiC).

Yamamoto does not, however, describe a process that would allow a satisfactory densification of a hollow C/C substrate, namely that would avoid the problem identified in the present application.

Chaudhuri relates to a process of forming a protective coating on the inside face of a crucible. As explained in the passage for Col. 1, l. 39 to Col. 2, l. 8, a coating is formed using a reactive gas, which is fed through a tube extending into the inside volume of crucible, to the proximity of the bottom.

Thus, as in Sirtl, the purpose is to form a protective coating on the inside of the crucible and this is achieved by admitting the whole reactive gas flow through a tube opening into the inside volume of the crucible. No division of the gas flow to sweep both the inside face and the outside face of the crucible with "fresh" reactive gas is provided.

The AAPA (Fig. 11 of the present application) shows an enclosure with a reactive gas inlet opening into the enclosure at one end thereof and a gas outlet provided at the opposite end, whereby a gas is forced to flow through the enclosure. As explained in the description, stagnation of the gas entering the inside volume of a substrate causes undesired deposits (Id.).

Applying the teaching of Sirtl or Chaudhuri would provide feeding tubes to feed the reactive gas directly into the inside volumes of the hollow substrates. However, this would lead to unsatisfactory feeding of the outside faces, as explained above.

From the above, it is believed that the method according to the invention, in allowing both the inside face and outside face

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of a hollow substrate to be properly fed by a fraction of the reactive gas flow admitted into the enclosure, patentably distinguishes over the prior art. No art of record, either alone or in combination, discloses, teaches or suggests a method of densifying porous substrates that includes "dividing at least a portion of the reactive gas flow entering the enclosure into first and second non-zero fractions", as recited in amended Claim 1 or "directing a first non-zero portion, but not all, of the reactive gas flowing through the enclosure into the inside volume of the substrate," as recited in new Claim 22. For at least these reasons, Claims 1 and 22 are believed to be allowable.

Claims 3-8, 13-16, 20-21 and 23 depend directly or indirectly from Claim 1 or 22. The dependent claims are, therefore, believed to be allowable, for at least the reasons discussed above with respect to Claims 1 and 22.

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For all the foregoing reasons, it is respectfully submitted that the present Application is in a condition for allowance, and such action is earnestly solicited. The Examiner is encouraged to telephone the undersigned attorney to discuss any matter that would expedite allowance of the present Application.

Respectfully submitted,

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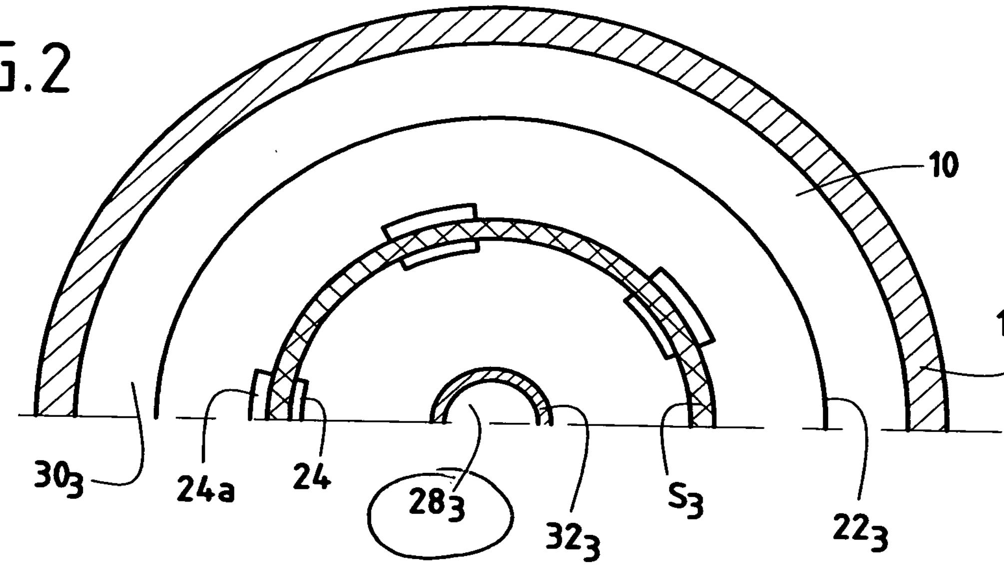
FIG.2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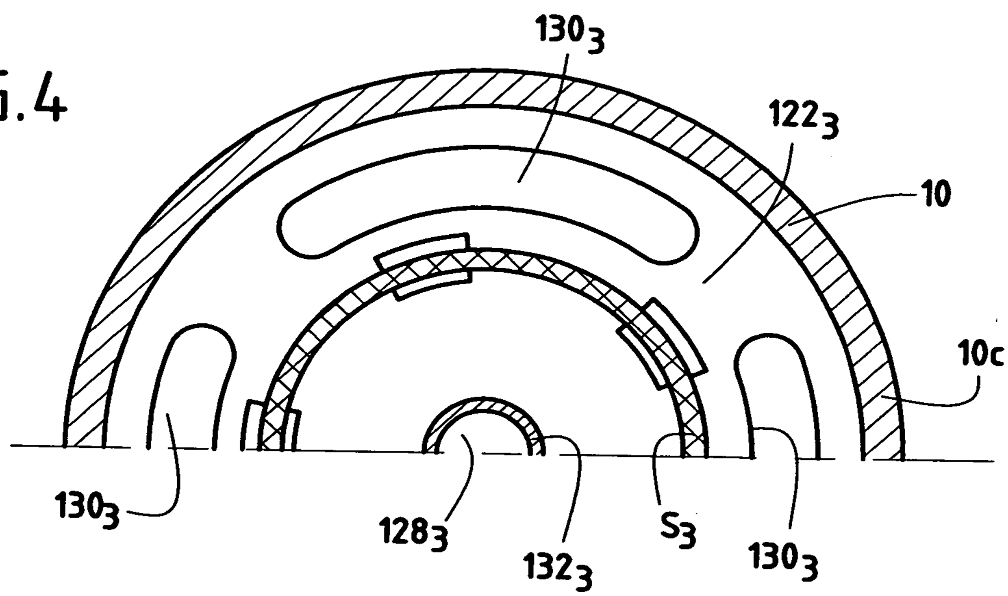
24a
24
28_3
32_3
S_3
22_3

FIG.4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130_3

Title: DENSIFYING HOLLOW POROUS SUBSTRATES BY CHEMICAL VAPOR INFILTRATION
Inventor Name: Delperier et al.
Appl. No. 10/024,272
Docket No.: BDL-371XX
Annotated Sheet Showing Changes

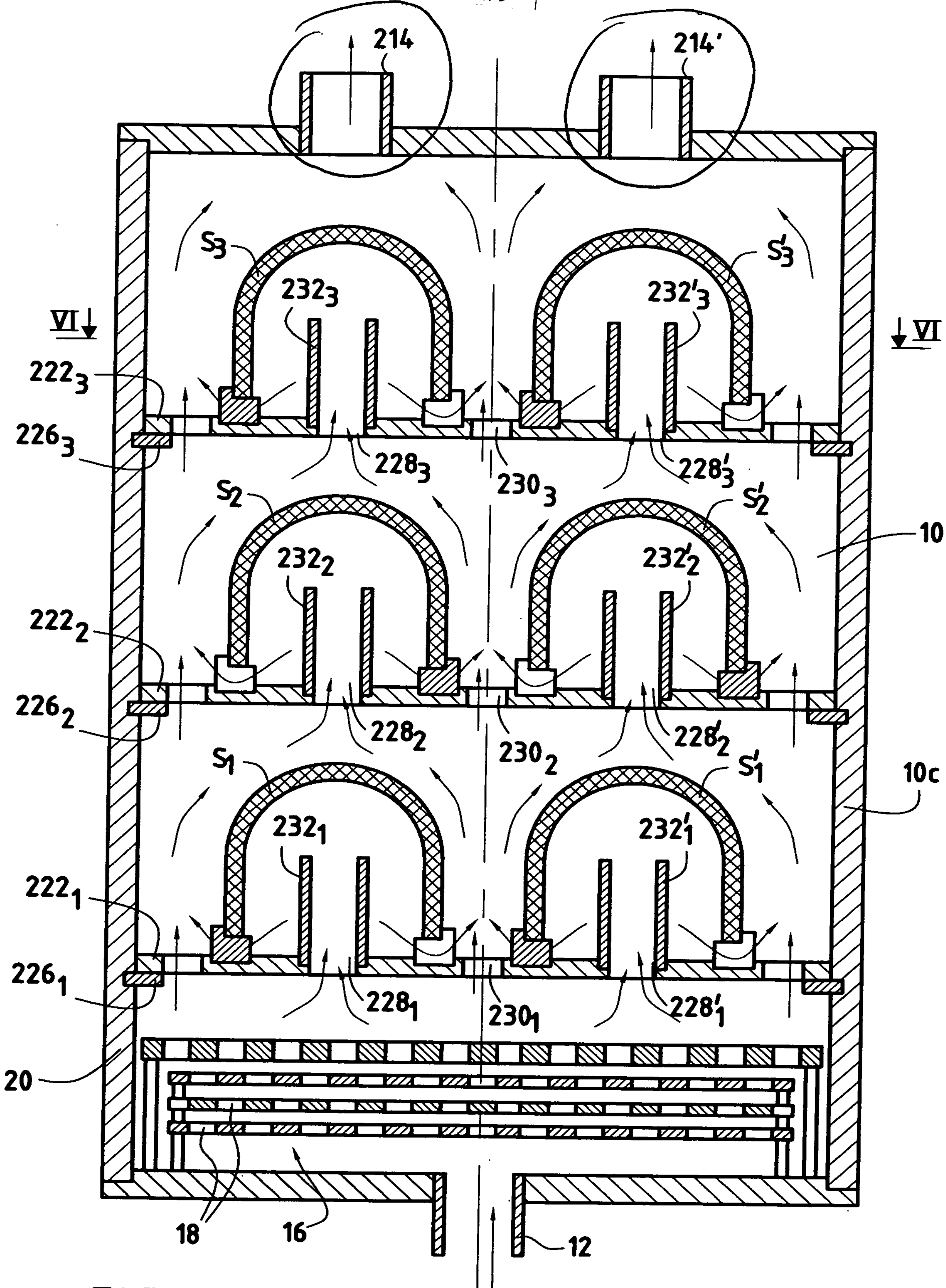

FIG.5

Title: DENSIFYING HOLLOW POROUS SUBSTRATES BY CHEMICAL VAPOR INFILTRATION
Inventor Name: Delperier et al.
Appl. No. 10/024,272
Docket No.: BDL-371XX
Annotated Sheet Showing Changes

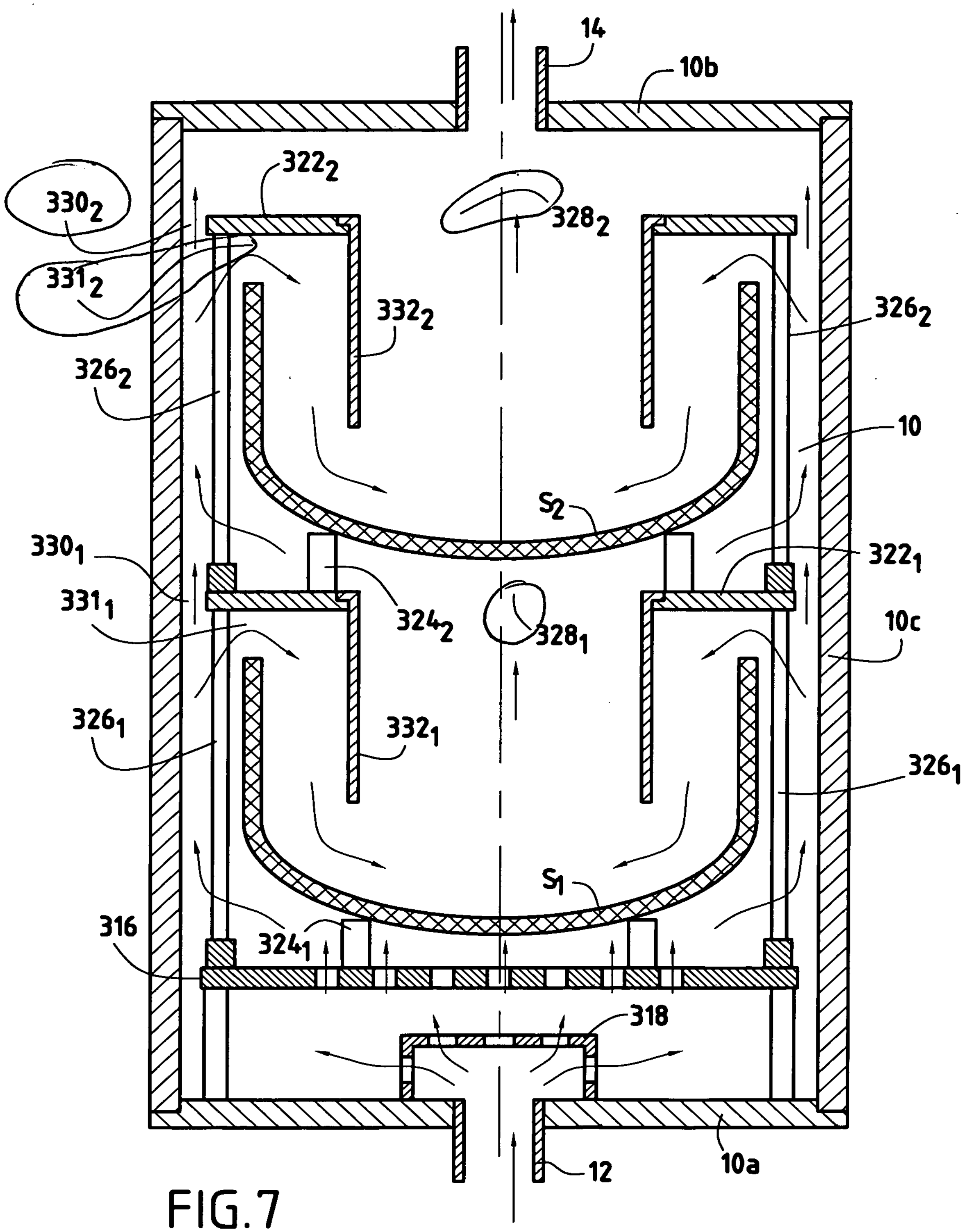

FIG.7

Title: DENSIFYING HOLLOW POROUS SUBSTRATES BY CHEMICAL VAPOR INFILTRATION
Inventor Name: Delperier et al.
Appl. No. 10/024,272
Docket No.: BDL-371XX
Annotated Sheet Showing Changes

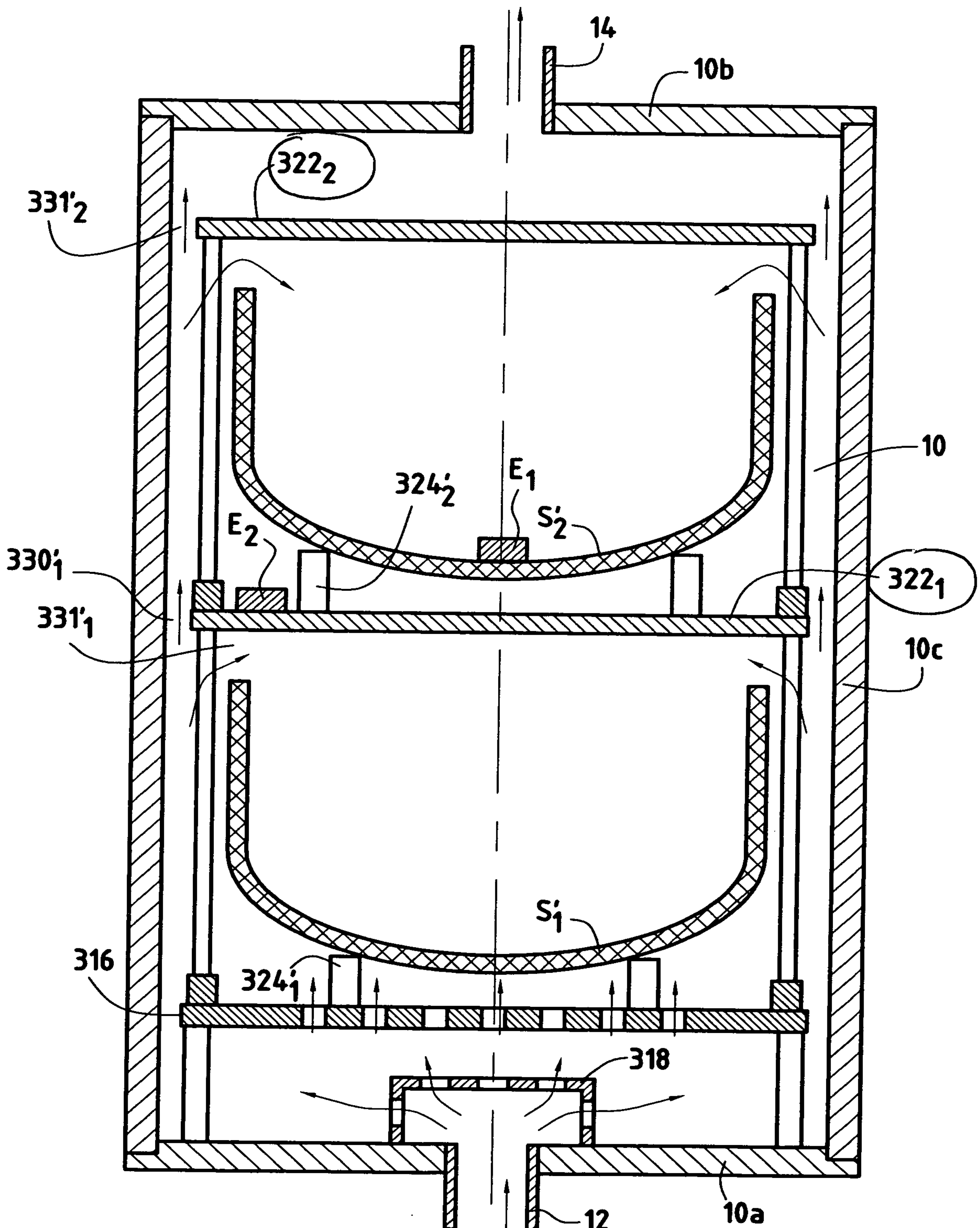

FIG.11

(PRIOR ART)

FIG.12
(PRIOR ART)

FIG.13
(PRIOR ART)